Conformation and size evolution of iron/organic matter colloids during their synthesis: impact on their metal binding properties

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Natural complexes are known to control the dynamic of many metal and metalloids in the environment and more specifically the Arsenic. Among them, the complexes composed of Fe as nano-oxides or clusters and organic matter (OM) have been pointed to be of a major importance by the way of their ability to capture and release the Arsenic within the humid zones. In a recent study, we investigated the complexes morphology by XAS, SAXS and SANS measurements combined with contrast variation method. We performed the experiments on natural and synthetic Fe/OM colloids formed from Fe(II) titrations of humic acids [1-2]. Results displayed that Fe/OM colloids can be view as a mixed fractal superimposed scaffolds whose sizes and densities increase when the Fe/OM ratio is increasing. At low Fe/OM ratio, the two scaffolds are dense and of about the same size, typically 100-150 nm diameter. The material is homogenously distributed inside the OM matrix while Fe is organized at lower scale with small compact unities of 5 nm of Fe nano-oxides. At higher Fe/OM ratio, the small Fe-oxides unities aggregated in larger objects of typical size of 10 nmwith a resulting opening of the Fe scaffold structure (decrease of the fractal dimension from 2, blue intermediate structure, to 1.7, red intermediate structure) and an increase of the global size up to 400 nm. The OM partremains compact and increases in size of a factor 2. The key information is that, when Arsenic is introduced in the system, for identical initial As/Fe ratio, the larger and open structures capturea larger amount of Arsenic. These results clearly show that the Fe concentration is not the single parameter that control the complexes binding properties. Both morphology and complexes sizes are also the driving parameters of the Arsenic adsorption.The next step of the story is now to understand more deeply the mechanisms which control the conformation of these colloids, namely what factors induce the transition between the small dense structures to the larger open conformations.

References

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